Lead Poisoning Prevention Program
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HealthCare Provider Information
Children (≤ 17 yrs) With Elevated Blood Lead Levels (EBLLs)
Medical Evaluation and Recommendations

This document is intended to provide evidence-based guidance for healthcare providers caring for children **(** ≤ 17 years of age) with confirmed EBLLs.

Confirmed EBLL: Venous blood lead level ≥10 Fg/dL.
Any capillary level ≥10 Fg/dL MUST be confirmed with a venous level.

GENERAL RECOMMENDATIONS:	
All children with a current or past EBLL need to have this listed in their permanent medical problem list (even if EBLL has resolved, these children need surveillance for problems that may develop later) (4).	
PHYSICAL EXAM:	
All children with venous EBLL $20 Fg/dL must have a complete physical exam. For levels between 10-19 Fg/dL a physical exam is recommended. **Following are areas of the physical exam that deserve special attention.**	
Hearing/speech:	Auditory function in children can be impaired, even at blood lead levels < 10 Fg/dL (5). Speech delays can also occur (4).
HEENT:	Lead lines on gingival tissue (rarely seen today unless severe prolonged exposure) (4).
Growth:	Several studies have shown a negative correlation between blood lead level and stature. NHANES III found a significant negative association between blood lead concentration and stature and head circumference in children ages 1-7 years. Regression models predicted reductions of 1.57 cm in stature and 0.52 cm in head circumference for each 10 Fg/dL increase in blood lead concentrations (2).
Neurodevelopment:	Lead exposure can: • Decrease IQ, even at levels #10 Fg/dL (3). • Increase behaviors such as distractibility, impulsivity, aggression, short attention span, poor organization, lack of persistence, daydreaming (4).
Neurologic:	Findings suggestive of acute encephelopathy (rarely seen with BLL < 70 Fg/dL).
Referral for formal neurodevelopmental testing:	Formal neurodevelopmental testing is recommended if any abnormalities found on developmental screening or concern about other neurodevelopmental risk factors (e.g. teen-age mother, poor parenting skills, inadequate cognitive or emotional stimulation, child abuse, poverty, genetic disorder, poor nutrition). Although chelation therapy has not been shown to be effective at reversing neurodevelopmental deficits due to lead poisoning, it is possible that early intervention/stimulation programs may be helpful (4).

Developmental surveillance:	**Developmental surveillance is recommended for all children with EBLLs or prior EBLLs.** The period of increased risk for the expression of lead-associated neurodevelopmental problems continues after lead exposure has been remediated and BLLs reduced. Any child that has **ever** had an EBLL should have on-going neurodevelopmental monitoring with special attention during critical transition points: • **First grade:** Children begin acquiring academic skills. • **Fourth grade:** They use these basic skills to learn new material. • **Sixth or seventh grade:** They need higher order planning and organizational skills (4).
Sexual development:	A cross-sectional study found that African American and Mexican American girls with BLL of 3 Fg/dL had delayed pubertal development compared with girls with BLL of 1 Fg/dL (7).
LABS:	
How long should it take for an EBLL to decrease to < 10 Fg/dL? Time (# of months required to achieve a blood lead level < 10 Fg/dL) = 0.845 x peak lead level. A retrospective analysis of children with venous blood lead levels 10-29 Fg/dL, receiving case management, but not receiving chelation found a linear relationship between mean time for blood lead to decline to <10Fg/dL and peak blood lead level (6). NB: After chronic lead exposure, increased metabolic activity (i.e. broken bones, growth spurts, pregnancy) can result in increased BLL due to mobilization of lead stored in body tissues.	
Hgb/hct:	All children should be assessed for anemia regardless of their lead exposure (4). Lead can cause anemia from: (a) Acute high lead exposure causing hemolytic anemia (b) Chronic lead exposure interferes with heme synthesis and decreases RBC lifespan. Frank anemia is not an early manifestation of lead exposure and is evident only when BLL is significantly elevated for prolonged periods (1).
Peripheral smear:	Not recommended (findings are non-specific) (4).
Iron studies:	Children with EBLL often have associated iron deficiency. Serum ferritin is the best measure of iron status in children.
Kidney function:	No evidence to support routine evaluation of renal function in children with asymptomatic EBLLs, but if chelation to be used test kidney function prior and during treatment (4).
Hair/fingernail/ tooth lead measurements:	Not recommended (not a reliable method of estimating body burden of lead) (1,4).
ZPP (zinc protoporphyrin):	[aka erythrocyte porphyrin (EP) or free erythrocyte protoporphyrin (FEP)]. A measure of past lead exposure. Not sensitive for lead levels < 25 Fg/dL. May be used for evaluating children with BLL $25 Fg/dL without a steady decline despite medical or environmental interventions. These measurements may help differentiate EBLL due to ongoing exposure versus rebound after treatment. Iron deficiency can also cause an elevated EP. EP >150 is almost always due to lead. EP 35-150 may be due to lead or iron deficiency (1,4).
IMAGING STUDIES:	
Abdominal X-ray:	Obtain if acute ingestion of objects that may contain lead (e.g. lead sinkers, curtain weights, jewelry, paint chips) or if prolonged EBLL and unable to identify source of exposure (1,4).

X-ray of long bones:	"Lead lines" due to growth arrest indicate chronic exposure (not present unless BLL >50 Fg/dL). Rarely provide information for case management (4).
X-ray fluorescence of long bones:	Use of radioactive source to provide noninvasive estimation of lead in bone. Currently used only for research.
NUTRITION:	
All children with EBLLs are at risk for poor nutrition.	
Iron:	Children with EBLLs may be at risk for iron deficiency due to behavioral, nutritional, and socioeconomic factors. An iron rich diet may decrease lead absorption. Encourage adequate iron intake by introducing iron-fortified cereals and pureed meats at appropriate developmental stages. Iron supplementation recommended when iron deficiency anemia is documented (4).
Calcium:	Dietary calcium competitively inhibits lead absorption (adequate intake 0-6 months 210 mg/day; 7-12 months 270 mg/day; 1-3 years 500 mg/day; 4-8 years 800 mg/day). No clinical evidence that supplementation beyond AI level in children with EBLLs has a clinical effect on BLL, so calcium supplementation is not necessary if child is consuming adequate dietary calcium (4).
Vitamin D:	Lead impedes Vitamin D conversion into active form, 1, 25- dihydroxyvitamin D. Assure adequate Vitamin D and calcium in the diet (1,4).
Zinc:	Animal studies suggest high zinc inhibits absorption and retention of lead, but human studies have not shown a significant effect. Zinc supplementation is not recommended in children with EBLLs (4). Chelation therapy can deplete zinc so if administering chelation therapy it is important to monitor and replace zinc.
Vitamin C:	To improve iron absorption in children 6 months of age and older, encourage two servings per day of foods rich Vitamin C (e.g., fruits, vegetables, or juice) (4).
WIC	If WIC enrolled notify local WIC program of EBLL. Children with EBLLs should be referred to WIC in order to assure nutritional counseling and access to healthy foods.
Regular meals & snacks:	Encourage caregivers to provide regular meals & snacks. More lead may be absorbed in the fasting state (4).

References:

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4. Centers for Disease Control and Prevention. Managing Elevated Blood Lead Levels Among Young Children: Recommendations form the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta:CDC; 2002.
5. Osman, K. et al. Lead Exposure and Hearing Effects in Children in Katowice, Poland. Environmental Research 1999;80(1):1-8.
6. Roberts, J.R. et at Time Required for Blood Lead Levels to Decline in Nonchelated Children. Clinical Toxicology;39(2):153-160.
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LEAD POISONING DISEASE REPORTING AND FOLLOW-UP GUIDELINES

The following information has been excerpted from the State of Oregon's Disease Reporting and Follow-up Guidelines. The full document can be found at www.healthoregon.org/lead.

DESCRIPTION OF LEAD POISONING

For the purpose of these guidelines, persons with EBLLs are considered to have lead poisoning. Lead poisoning can affect both children and adults, although the effects may very markedly with age. It is convenient, albeit somewhat artificial, to divide lead poisoning into an acute disease that relates to current BLLs, and a chronic disease that relates to the cumulative effects of body lead burden. Bear in mind that persons with very high BLLs ($ 70 Fg/dL in children) should be treated as medical emergencies, regardless of overt symptomatology. Ingestion of a metallic object that may contain lead can result in an EBLL within hours. Any child that has ingested such an object should receive immediate medical attention including a blood lead test and abdominal x-ray. Absorbed lead is detectable in blood, soft tissue, and bone. The half-life of lead varies from about a month in blood, 1-1.5 months in soft tissue, and about 25-30 years in bone (ATSDR 1999).

ACUTE DISEASE

Acute exposure to lead generally means exposure for a short times, but at high levels. There are few data sources available for acute exposures in humans. This may be a function of the time required for the expression of effects (decreased heme synthesis, neurobehavioral changes, increased blood pressure, and interference with Vitamin D metabolism) and the modes of exposure in human, which are repeated ingestion of lead containing dust and/or dirt for children and continuous occupational inhalation exposures for adults. The most common symptom of acute lead poisoning is colicky abdominal pain evolving over days to weeks. Constipation, diarrhea, and nonspecific complaints of irritability, fatigue, weakness and muscle pain may also occur. These symptoms are seldom caused by BLLs less than 50 Fg/dL. In more severe cases, warning signs of acute, serious brain swelling include vomiting, irritability, restlessness, tremors, and progressive drowsiness. These symptoms may herald the onset of seizures, coma, and possibly death. The BLLs associated with encephalopathy in children vary from study to study, but BLLs of 70-80 Fg/dl or greater appear to indicate serious risk (ATSDR 1999).

CHRONIC EFFECTS

Chronic lead exposure generally means exposure to low to moderate levels of lead over a long period of time. Recent studies suggest that lead absorption is harmful at any concentration. Relatively low blood lead levels rarely cause overt signs and symptoms, but such exposure can cause permanent damage-especially in young children-including decreased IQ, developmental delays, and behavioral disturbances.

CHELATION THERAPY

Chelating agents solubilize lead, depleting it from soft and hard tissue and thereby reducing its acute toxicity. While chelation therapy is considered a mainstay in the medical management of children with BLLs >45 Fg/dL, it should be used with caution. Primary care providers (PCP) should consult with an expert in the management of lead chemotheraphy prior to using chelation agents. If unaware of a center with such expertise, PCPs should contact the Oregon Poison Center or the state lead poisoning prevention program for the names of accessible experts. In the short term, chelation can redistribute body lead, causing an increase in lead concentrations in soft tissue, including the brain. Some chelators may remove essential minerals as well as lead. There is general agreement that individuals with very high BLLs (in children $45 Fg/dL; in adults $100 Fg/dL) should be chelated. Patients with lower BLLs (children, < 20 Fg/dL; adults, < 65 Fg/dL) are usually not chelated unless symptomatic and/or unresponsive to removal from exposure. For patients with in-between BLLs, chelation may or may not be appropriate.

The table on the following page is to be used as guidance. Case managers and medical providers should consider individual patient characteristics and caregiver capabilities and adjust the frequency of follow-up tests accordingly.

FOLLOW-UP SCHEDULE FOR CHILDREN WITH EBLLs				
BLL (Fg/dL)	**Confirmation Testing * (Venous)**	**Follow-Up Testing (Venous)**	**Duties of Primary Care Provider (PCP)**	**Case Management Duties of Local/County Health Department**
5-9	Not required unless child under 12 months of age or recent known exposure. Confirm within 3 months.	3 months	Provide source identification and risk reduction education.	No case management required.
10-14	3 months	3 months	Complete and return medical information form received from county/local health department. Assure follow-up blood lead testing. Physical exam recommended. Include history of EBLL in problem list of child's permanent medical record. If WIC enrolled notify local program of EBLL. Monitor for developmental problems.	Have PCP complete medical info form. Send letter to caregiver confirming child's BLL. Complete questionnaire over phone to identify possible hazards. Provide nutritional and risk reduction education. Refer to WIC, social services or public assistance programs as needed. Assure follow-up testing. Send copies of forms to DHS and PCP.
15-19	1 month	3 months	Above actions. Physical exam recommended.	Above actions, plus: Perform on-site investigation. Advise PCP of environmental results. Refer family to lead hazard control services if applicable and/or available. Send copies of forms to DHS.
20-44	1 week- 1 month	1 month	Above actions, plus: Children with EBLL $\geq$20 Fg/dL should have a complete physical exam.	Above actions.
45-59	48 hours	Chelation with subsequent follow-up	Above actions plus chelation therapy.	Above actions.
60-69	24 hours	Chelation with subsequent follow-up	Above actions plus chelation therapy.	Above actions.
> 70	Immediately as an emergency lab test.	Chelation with subsequent follow-up	Above actions, plus hospitalize child for chelation therapy immediately. The child should not be permitted to return to any environment that would expose him/her to lead.	Environmental on-site investigation and sampling must be done as soon as possible. The child should not be permitted to return to any environment that would expose him/her to lead.

*** If a child with an elevated screening test result is less than 12 months old, or if there is reason to believe that a child's BLL may be increasing rapidly (e.g. foreign body ingestion of leaded object) consider performing the confirmatory test sooner than indicated in the accompanying schedule.**

Any screening BLL above 10 Fg/dL must be confirmed with a venous sample. The higher the BLL on the screening test, the more urgent the need for confirmatory testing.